

Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.

U. S. DEPARTMENT OF
AGRICULTURE
FARMERS' BULLETIN No. 1028

STRAWBERRY
CULTURE
EASTERN UNITED STATES



LIBRARY
COASTAL PLAIN EXPERIMENT STATION
TIFTON, GEORGIA

THE STRAWBERRY is the most popular of the small fruits. It is produced on a large scale for market in many localities and is found in almost every home garden.

The fundamental principles of strawberry growing are quite similar everywhere, but methods of culture differ somewhat in different parts of the country because of differences in soil and climate.

This bulletin discusses commercial methods in the eastern United States, the territory including approximately one tier of States west of the Mississippi—that part of the country where farm crops are usually grown without irrigation—but not including the South Atlantic and Gulf coast region.

The successful cultural methods followed in the different strawberry districts are described. These commercial methods are not all applicable to the growing of strawberries in the home garden, but as the underlying principles are the same, the practices may be modified without difficulty.

The bulletin gives complete directions for planting, fertilizing, cultivating, harvesting, and marketing, also methods of freezing the surplus for future use.

STRAWBERRY CULTURE: EASTERN UNITED STATES

By GEORGE M. DARROW, *senior pomologist, Division of Fruit and Vegetable Crops and Diseases, Bureau of Plant Industry*

CONTENTS

	Page		Page
Commercial importance.....	1	Fertilizers.....	23
Locating the plantation.....	2	When to apply fertilizers.....	24
Factors to be considered in choosing varieties.....	4	Use of lime.....	24
Preparation of the soil.....	6	Irrigation.....	24
Cleaning the soil.....	6	Overhead irrigation.....	25
Rotations.....	7	Surface irrigation.....	25
Adding humus and fertility.....	7	Mulching.....	25
Establishing the plantation.....	8	Frost protection.....	28
Time of planting.....	8	Picking.....	28
Systems of training.....	10	Renewing the plantation.....	30
Marking rows.....	13	Mowing the field.....	30
Number of plants required for an acre.....	13	Burning leaves and mulch.....	31
Care of plants before setting.....	14	Thinning the plants.....	32
Setting the plants.....	15	Propagation.....	32
Care during the first summer.....	19	Plants for spring setting.....	33
Removing the flower stems.....	19	Plants for fall setting.....	33
Cutting runners and thinning and spacing plants.....	19	Plants with perfect and with imperfect flowers.....	34
Tillage.....	20	Uses of the strawberry.....	35
Companion crops.....	21	Cold storage.....	35
Strawberries as an intercrop.....	22		

COMMERCIAL IMPORTANCE

STRAWBERRIES are widely grown in the eastern part of the United States. The region to which this bulletin applies is shown in figure 1 and includes in general the humid part of the eastern half of the United States, except a narrow strip along the South Atlantic and Gulf coasts where the elevation is less than 500 feet. The southern boundary is for the most part the northern limit of the Coastal Plain region. This boundary extends from the mouth of the Potomac River southwest through North Carolina, South Carolina, Georgia, Alabama, Mississippi, Arkansas, and Texas. The western boundary is approximately the eastern edge of the Great Plains area.

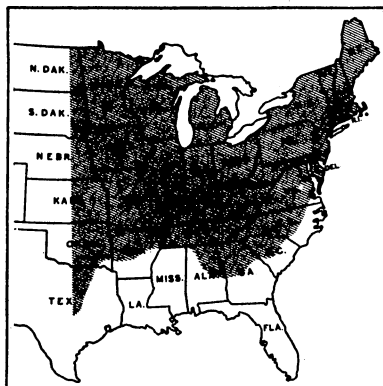


FIGURE 1.—Map of the eastern half of the United States. The shaded portion indicates the region to which this bulletin applies.

The strawberry is the most important small-fruit crop in the United States. Not only is it one of the most popular fruits, but it is the most widely grown, being cultivated commercially from northern Maine to Florida, and in all the irrigated areas of the West where fruits can be grown. It is particularly adapted to the home garden,

as it ripens earlier than any other cultivated fruit, and enough to supply an ordinary family can be grown on a very small area.

In years past the strawberry was grown only in the home garden and by gardeners located within a few miles of the market. The fruit was consumed during a very short season, averaging about 3 weeks. Since about 1860 the period of its consumption has been greatly extended, and in the large city markets strawberries can now be obtained throughout the year. Relatively large quantities are consumed from early April until July, and smaller quantities of the ever-bearing varieties may be purchased from July until November, after which berries are shipped from Florida.

The map (fig. 2) shows the location of the principal strawberry-producing districts in the United States and the approximate shipping season for each strawberry-producing section. Strawberries which supply the northern markets after the first part of June are largely raised in the immediate

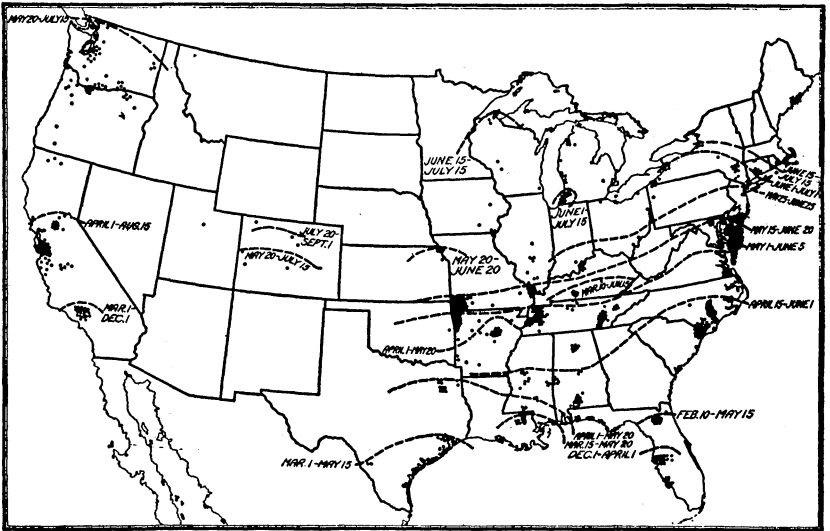


FIGURE 2.—Outline map of the United States, showing the approximate shipping season for each strawberry-producing section. Dots show specific locations of the more important producing areas.

vicinity of the towns and cities and are not shipped any great distances. While strawberries are grown extensively in the Northern States, the acreage is scattered rather than centralized in certain definite regions, as is the case in the States farther south and west.

LOCATING THE PLANTATION

The factors which should be considered first in locating a commercial strawberry plantation are the accessibility of markets, transportation facilities, labor supply, community interests, and climate.

The possibility of securing labor to harvest the fruit should be carefully considered, as the commercial success or failure of the crop will often depend upon this factor alone.

When strawberries are to be grown for the general markets it is usually better to select a locality where other growers are raising them.

Pickers can usually be secured more easily in such places, and because of the possibility of cooperative handling, baskets, crates, and other supplies can be obtained to better advantage. Furthermore, consignments from several growers can be combined, often making carload shipments possible when, without this combination, small shipments would have to be made by express.

The strawberry may be grown in any part of the United States except in the arid and semiarid regions of the West where water for irrigation is not available. Within the northern part of the United States, however, are certain areas where only a few varieties have proved hardy enough to grow successfully. In northern Illinois, in northern Missouri, and in Wisconsin, Minnesota, Iowa, Nebraska, South Dakota, and North Dakota most varieties are somewhat tender, and none should be planted widely until careful trial has proved it hardy. Certain sorts, however, especially the Dunlap, Warfield, and Progressive, are exceptionally hardy and may be grown throughout this area, except perhaps in the most exposed places. If given winter protection, they may be grown even in the colder parts of Iowa and Minnesota.

In selecting the specific site for the plantation these additional factors should be considered: Air and water drainage, slope, the exposure of the land, and the character of the soil.

In localities subject to late spring frosts, a site somewhat elevated above the surrounding country should be selected. Cold air settles into low places, and frosts occur there more frequently than on the more elevated sites. As the strawberry plant is close to the ground, the blossoms are often caught by unseasonable frosts when the blossoms of fruit trees occupying the same ground would escape. A site with even a slight elevation above the surrounding country will often escape injury from frosts because of the air drainage thus provided.

Strawberries thrive best on soil which is naturally moist but not wet. Plants on wet soil usually make very little growth in the summer and are likely to be killed when the ground freezes in the winter. Therefore, the site should be well drained.

Ordinarily a site having a gradual rather than a steep slope should be selected for the strawberry. Heavy precipitation, together with a deficient supply of humus, causes soils to wash badly on steep slopes, and cultivation will be expensive. Where strawberries are grown on hillsides, the rows should follow the contour of the hill, as shown in figure 3.

By selecting different slopes, it is possible to vary the period of ripening several days. Where it is important that the berries ripen as early as possible, a site having a southern exposure should be selected. Such an exposure absorbs more of the heat of the sun and the ground is warmer than on a northern slope. Berries may be secured from such plantations several days in advance of those on northern slopes. Where it is desirable that the crop ripen as late as possible, a northern exposure should be selected. Such an exposure is cooler and the moisture conditions are usually better than in a southern exposure.

The strawberry not only has a wide climatic adaptation but may be grown successfully upon almost any type of soil, from coarse sand to heavy clay, provided it is well supplied with moisture and at the same time well drained. In some regions strawberries are usually

grown on sandy soils, while in others clay soils are preferred; a heavy yield may be secured in both cases. Although strawberries will grow in practically any kind of soil, particular soils are preferred for certain purposes. Thus, when early fruit is desired a sandy soil is often chosen, since the berries ripen somewhat earlier on sandy than on clay soils, other conditions being the same.

The different varieties of strawberries show decided differences in their behavior on different soils. Some are much better suited to clay or heavy soils, while others are adapted to sandy or light soils. All varieties, however, show less differences in their adaptation when there is a good supply of humus in the soil than when the humus is deficient. Therefore, in determining the suitability of a soil for growing strawberries the humus content with its effect on soil moisture and fertility is more important than the type of soil.



FIGURE 3.—A field of Gandy strawberries at Parkersburg, W. Va., trained to wide matted rows and well mulched. The rows follow the contours of the field.

FACTORS TO BE CONSIDERED IN CHOOSING VARIETIES

In the United States the strawberry is grown in the home garden, by market gardeners, by truck growers, and also as a farm enterprise. Occasionally, the fruit is grown in a greenhouse as a forced crop for a very special and high-priced market.

The variety to be planted in any locality will depend upon the climate, the soil, and the purpose for which the crop is to be grown. In the early history of the strawberry industry in this country, when there were fewer varieties, a single sort with recognized superiority over others was often grown nearly throughout the United States. With the development of the industry, however, varieties adapted to the climates of different regions have been produced. In the South the Missionary and Klondike are almost the only varieties grown. In other localities certain varieties especially adapted to local climate and needs have become dominant. In the northeastern part of the

United States climatic conditions vary greatly within comparatively short distances, and because of this a larger number of varieties are grown. Moreover, the soils in that part of the United States are variable and many varieties of strawberries are more or less restricted in their soil adaptation.

As the strawberry industry has developed, varieties particularly adapted to special purposes, also, have been introduced. Some bear firm berries especially adapted to long-distance shipment. Others have large attractive berries of the best quality but too soft for long shipment and therefore suitable only for the local market and for home use. Still other varieties which have a dark-red, firm flesh and a brisk subacid or acid flavor are adapted to canning and to the soda-fountain trade.

Varieties of strawberries should be suited to the purpose for which they are to be grown and especially adapted to the particular soil and climate where they are to be grown. The experience of local growers is one of the best guides in selecting the most profitable varieties for planting in any community.

In nearly all regions varieties which will ripen at times when the market is in the best condition and when there is the least competition from other localities must be selected. Thus, in Florida, strawberries ripen and are shipped to northern markets from December 1 until the last of March or into April. As the season advances, localities farther north and nearer the larger cities supply the markets, until in June the territory immediately around Philadelphia, New York, and Boston supplies the same markets which in March were supplied largely by Florida; in April by Florida, North Carolina, and points farther west; in early May by North Carolina and Virginia; and in the latter part of May by Maryland and Delaware. When several points supply the same market, as in this instance, those farthest from the markets are at a disadvantage, as the freight and express rates are higher than for nearer points, and usually the berries cannot arrive in as good condition. The more southern points, therefore, raise chiefly early sorts, for late varieties compete with berries grown near the large markets of the North.

For the home garden, varieties that have the best dessert quality and ripen through a long season or in succession, without reference to their ability to stand long shipments, are most desirable. However, several varieties should be grown, so that a succession of fruit through a long season may be secured. Such berries are given intensive cultivation and may be treated somewhat differently from those grown for market.

Market gardeners also raise strawberries under intensive methods of culture; and since they are located near the markets in which their crops are sold, they have not been interested primarily in the shipping quality. However, at times such markets may be oversupplied with fruit, so that a part of the crop must be shipped to another market or held for a few days in storage. The market gardener, therefore, should pay more attention to the shipping quality of the varieties planted and should adopt more of the practices of truck growers.

For general-market purposes, however, varieties which have been found to be widely adapted should ordinarily be grown. Plants of such varieties can be secured more readily than plants of those which are restricted in their adaptation, and the well-known sorts are preferred in the markets.

When raising berries for the general market, only one or two varieties should be grown, as buyers prefer to secure full carloads of one variety rather than carloads of mixed varieties which may differ in their shipping qualities and may have different colors, shapes, and flavors. In most of the larger shipping regions, only one variety or at most two or three are grown.

Growers who produce strawberries for local markets often wish a succession of ripening throughout the season and may grow as many as three or four sorts to cover the very early, medium early, mid-season, and late periods of ripening.

Truck growers raise the fruit as one of their truck crops for the general market. Under such conditions the strawberry is given intensive culture, and the varieties raised must have good shipping qualities. Varieties which combine good shipping and high dessert qualities have been introduced, and it is becoming essential that truck growers as well as others raise these sorts.

When strawberries are grown as a farm enterprise the methods used are not generally intensive. In some localities, however, intensive methods have been adopted by farmers, who usually have been especially successful. They have found the thorough culture of a few acres more profitable than less intensive methods on a larger area.

In the discussion of cultural methods which follows, directions for growing the strawberry as a truck crop will be given, and where such methods differ from those used in home gardens that fact will be indicated.

PREPARATION OF THE SOIL

The preparation of the soil for planting strawberries usually should begin at least 2 years before the plants are to be set, or the plants should be set in soil which has received adequate preparation in growing other crops. Newly plowed sod land should not be used, because the grass roots might prove objectionable and because of the danger that white grubs will injure the plants. The land must also be freed of quack grass or any other seriously persistent weeds, and a suitable supply of humus must be furnished if not already present.

CLEANING THE SOIL

DESTROYING WHITE GRUBS

The larvae of May beetles, or June bugs, called white grubs, occur throughout the strawberry regions of the eastern part of the United States. They are commonly found in sod land, and are very destructive to strawberries planted on infested soil. The beetles lay their eggs in grasslands, and the larvae stay in the soil for 2 years before becoming mature. It is therefore essential, where white grubs cause serious damage, that the ground be freed from them by being planted to cultivated crops for at least two seasons before strawberries are set.

Where the grub is less threatening, the soil should be plowed in the autumn. The resulting exposure during the winter will kill many of the grubs. The following season some cultivated crop should be raised, the soil plowed again in the autumn, and the strawberries planted the following spring. As the grubs may travel for some distance in the soil, it is often necessary to have a plowed area around the strawberry field; otherwise, plants may be killed for some dis-

tance from the border by the grubs which come from the neighboring grassland.¹

EXTERMINATING QUACKGRASS AND WEEDS

It is not usually advisable to raise strawberries in a field where quackgrass is abundant, as it is almost impossible to kill out the grass after the plants are set, and if allowed to grow it will make the strawberry field unproductive. For a season or two before setting strawberries, land infested with quackgrass or other weeds which are difficult to eradicate, such as purslane, chickweed, and the like, should be freed by growing crops which require clean cultivation.

ROTATIONS

Since it is necessary, where white grubs are troublesome, that a cultivated crop be raised during at least one season before the strawberry plants are set, and since it is also essential that where such land is to be fitted for strawberries the sod be broken up in order to put it in good physical condition, growers should use some well-planned rotation as a means to this end. Desirable rotations include the clovers or other leguminous plants and truck or other cultivated crops.

In some localities the land on which strawberries are to be grown is kept in clover for 1 or 2 years, then plowed in the autumn and sowed to crimson clover or rye and vetch. Early the following spring the green-manure crop is plowed under and some vegetable crop, such as potatoes, beans, peas, or tomatoes, is raised. In the autumn, after the vegetable crop has been harvested, the land is plowed, or perhaps left without further attention until the following spring, when it is fitted for planting and strawberries are set. After one or more crops of berries have been obtained, the field is plowed and again seeded to clover. This rotation is suggestive only, as local conditions determine which crops are best.

ADDING HUMUS AND FERTILITY

The extent to which the land to be set to strawberries should be enriched will depend somewhat upon the length of time the berries are to be grown on it. In most localities the strawberry plantation is continued for several years on the same soil, and such soil should be put in the best possible condition before the plants are set. In other localities strawberries are grown for a single year and preparations may be less extensive.

Soils lacking in humus should be planted first to some green-manure crop or receive an application of stable manure. Soils very deficient in humus may need at least two green-manure crops turned under before strawberries are planted. Ordinarily, however, one crop of crimson clover or rye and vetch will be sufficient. Where these cannot be grown successfully, cowpeas, Canada peas, buckwheat, or some other commonly used green-manure crop can be substituted. The kind of green-manure crop to be used will differ in various parts of the country; the one best suited to the region should be used.

¹ For further information on white grubs, readers are referred to U.S. Department of Agriculture Farmers' Bul. 940, entitled "Common White Grubs."

Some growers have found that sufficient humus can be supplied by using a large quantity of stable manure on a hoed crop planted the year before setting strawberries, and then following the hoed crop with a green-manure crop. When practices such as are outlined here are used, little stable manure will be needed before the strawberry plants are set. It will seldom be convenient to use green-manure crops as a source of humus in the home garden; therefore, stable manure will generally be preferred.

Whatever the previous crop may have been, the land should be thoroughly pulverized immediately before the strawberry plants are set. If the soil has been plowed in the autumn, in many cases it will not need to be plowed again in the spring, thorough harrowing being sufficient.

Under most conditions, level culture should be used. Occasionally where the surface drainage is poor, a ridge on which to plant the strawberries may be made by throwing two or more furrows together and leveling with a plank drag. The height and width of the ridge should be determined by the character of the soil. Unless the drainage is very poor, the ridge should be relatively wide and only 2 or 3 inches high.

ESTABLISHING THE PLANTATION

TIME OF PLANTING

Temperature, moisture, and type of soil determine the time of planting.

Where there is a continuous covering of snow in the winter the planting can be done in the autumn, but where this is lacking, and alternate freezing and thawing occur, the planting should be done in the spring unless some protection is given the plants. In the Middle West, growers occasionally set plants in the autumn, but they must protect them during the winter with several inches of straw or with a heavy coating of stable manure containing considerable straw. In most of the Northeastern States the snow covering is heavy, and plants may be set in the autumn. However, if the season has been dry and the soil does not contain an abundant supply of moisture, strawberries cannot be planted safely in the autumn even in those States. Neither should the plants be set in the autumn in seasons when there is a surplus of moisture. Under either extreme, winter injury is likely to occur.

Plants may be set at any time in the spring or summer if moisture conditions are favorable; these are usually best in early spring, and most of the planting is done then. Where it is possible to irrigate, planting may be done at almost any time. Near large cities where the land must be utilized to the fullest extent and where abundant rainfall can be depended on, plants of certain varieties are often set in August or early in September and a crop secured the following year. When plants are set at this season a large quantity of stable manure is used, so that the plants may be protected as fully as possible during the winter and so that the roots can grow until very late in the autumn and start to grow early in the spring.

Plants may be set on sandy soils in autumn when it would not be safe to plant them on clay soils. When clay soils freeze and thaw, they are likely to heave the plants out of the ground and destroy them. As there is only a short time in the spring when conditions are just right for setting plants on clay soils, early autumn will often be found a more desirable planting season even on them. It is essential that plants on such soils be protected by a mulch in winter.

Where planting in the autumn is practicable, that season is most desirable, as the plants can become well established in the ground and begin growth very early in the spring. Also, sometimes it is possible to obtain labor in the autumn whereas it cannot be had in the spring. In general, however, early-spring planting is preferred by most growers, as the moisture supply is most favorable at that time. It is also much easier to secure nursery-grown plants in the spring, as nurserymen do not usually care to supply them during the period when planting conditions are best in the autumn, as they want to take advantage of those conditions for largely increasing their own stock.



FIGURE 4.—A, Chesapeake strawberries grown in hills under irrigation. The third crop is being harvested from this plantation. (Photographed at Bridgeton, N.J., June 10.) B, Chesapeake strawberries grown in hills in double rows. The rows in each pair are 8 inches apart and the plants 6 inches apart in the rows. From center to center of each pair of rows the distance is 3 feet 8 inches. (Photographed at Vineland, N.J., June 12.) C, Strawberries set in hills in triple rows. The plants are 12 inches apart each way. The alley between the sets of triple rows is 18 inches wide. (Photographed at Three Rivers, Mich., June 29.)

In southern New Jersey and the southern parts of Ohio, Indiana, and Illinois the usual planting season is late March and early April. Farther north the plants should be set in April or as early in May as it is possible to prepare the soil.

FALL-SET PLANTS FOR FANCY FRUIT

In New England, New York, New Jersey, and in some other parts of the North, gardeners sometimes set plants in August or early in September which produce a crop the following year. When this practice is followed the plants must be large, must have good root

systems, and must be set in rich moist ground. The plants are usually grown under the hill system, two rows of plants being set close together, as shown in figure 4, B. They should be set much closer than when planted in the spring, sometimes as close as 4 to 6 inches apart in rows 3 feet apart. Such plants ordinarily should be mulched with strawy manure in the autumn and given the best of care. They will produce very large fruit the following year, a few days later than the usual season for the variety. When the Chesapeake is used and irrigation is given as needed, crops as large as if the plants had been set in early spring and grown for a full year occasionally are produced, but the average yield from plants grown in this manner will not be as large as that from spring-set plantations.

SYSTEMS OF TRAINING

Two main systems of training strawberries, the hill system and the matted-row system, are in general use.

HILL SYSTEM

The hill system is the method of training under which all runners are removed from the plants as they appear, so that at the fruiting season there are no more plants than were originally set. Such plants become much larger than those grown under the matted-row system and bear more than do the individual plants in matted rows where the runners are allowed to remain and take root. Under the hill system the plants are set 6 to 24 inches (commonly 12 to 18 inches) apart in rows which are 3 to 3½ feet apart. When such a planting distance is adopted a horse cultivator can be used, greatly reducing the expense of tillage. In a home garden where horse cultivation cannot be given, the distance between the rows need not be more than 18 inches. Sometimes two rows of plants are set from 6 to 24 inches apart; then a wider space is left and two other rows are set. These are called double or twin rows. Sometimes triple rows are set. These are, however, simply modifications of the hill system and the plants are set the same distance apart in the row. Figure 4, A, B, and C, shows strawberries set under the hill system, in single, double, and triple rows, respectively.

MATTED-ROW SYSTEM

Under the matted-row system the plants are set in rows, and all or part of the runners which form during the summer are allowed to take root in the spaces between the original plants. By the end of the season a mat of plants will have formed. The width of this mat may vary from a few inches to 2½ or 3 feet, and in a few localities may even reach 4 or 5 feet.

It is easier to harvest the berries from plantations where the rows are narrow, and some varieties produce better under such conditions. When the width is greater than 2 feet, some ripe berries along the center are likely to be overlooked by pickers, and unless the plants are well spaced many berries are likely to be small. In general, therefore, the width of the matted row of plants should not be more than 24 inches, and many growers find that rows about 12 inches wide are most desirable. Matted rows may be grown on the same plan as double or twin rows under the hill system—that is, two rather narrow matted rows from 6 to 24 inches apart may be allowed

to form, then a wide alley be left and two other rows 6 to 24 inches apart formed.

Under the matted-row system the plants should be set 18 to 42 inches apart in rows 3 to 4½ feet apart. Varieties, such as the Chesapeake, Superb, and Columbia, which do not make runners readily, should be set no farther apart than 18 inches, while the Dunlap, Warfield, and others may be set at a greater distance.

If there is much danger of loss of plants from white grubs or severe droughts, the planting distance in the rows should not exceed 18 inches for all varieties; then if a plant is lost through any cause, the adjoining plants will make sufficient runners to form a continuous mat.

On steep slopes the rows should be somewhat farther apart than on level or nearly level land. Ordinarily they should be at least 4 feet apart on such sites. Certain varieties which make few runner plants on poor land may make a large number on very fertile land. The plants of the Chesapeake, for example, should be set no farther apart than 18 inches on land of moderate fertility, but on very fertile land they will make a large number of runners and may be set much farther apart.

In matted rows the runners may be allowed to root almost at will or may be placed by hand. When the runners are set by hand the row is called a spaced row. Sometimes only one runner is set on each side of the mother plant, and sometimes many runners are set, all 6 to 10 inches apart. The system under which runner plants are spaced at equal distances on each side of the parent plant and in rows parallel to them is sometimes called the hedge-row system and each row a hedge row. In the spaced-row system the plants are simply spaced approximately equidistant from each other.

In practice, the hedge-row and spaced-row systems are used very little except on the Pacific coast. Only the matted-row system, in which the runners are allowed to form and root at will, is used extensively. Figure 5, *A* and *B*, illustrates the matted-row and the spaced matted-row systems, respectively.

In these various modifications of the matted-row systems, where only a limited number of runner plants are desired, all plants that form after the desired number have developed are removed, as in the hill system.

ADVANTAGES AND DISADVANTAGES OF EACH SYSTEM

The system of training to be used is determined chiefly by the climate, the variety, the soil, and the preferences of the grower. Commonly where the land is irrigated and tillage is intensive, growers find the hill and spaced matted-row systems better adapted to their purpose than the ordinary matted row.

Where there is considerable danger of injury from white grubs, from drought, or from severe winters, the hill system is not satisfactory; and if it is used, there is frequently so great a loss that the remaining plants will not produce a profitable crop on the acreage. In such localities the matted-row system should be used; and although some plants may be killed, enough will ordinarily survive to produce a good yield.

In rainy seasons the berries are somewhat more likely to rot in matted rows than if grown in hills, which permit a better circulation

of air around each plant. In seasons of less abundant rainfall the larger yield of fields set in matted rows will in most cases more than make up for any loss in wet years.

DIFFERENT VARIETIES FOR DIFFERENT SYSTEMS

Certain varieties are much better adapted to the hill than to the matted-row system, while others give their best results in matted rows. Thus, the Chesapeake, Clark, and Marshall are frequently grown in hills, while the Dunlap, Gandy, and Aroma are rarely grown in any but matted rows. The last-named varieties make a large number of runners, and the expense of removing them would be comparatively heavy.



FIGURE 5.—A, Strawberries grown in accordance with the wide matted-row system in a peach orchard. (Photographed at Bridgeville, Del., June 2.) B, Marshall strawberries grown in spaced matted rows. The rows are $4\frac{1}{2}$ feet from center to center. (Photographed at Marshfield Hills, Mass., June 20.) C, Strawberry plants set 30 by 36 inches apart under overhead irrigation. (Photographed at Rancocas, N.J., June 16, about 2 months after the plants were set.)

Certain varieties make very few runners on light soils and a large number on heavy soils. Such varieties are more suited to the hill system of culture on sandy soils and to the matted-row system on heavier soils.

In the northern United States the hill system may be used in home gardens, in fields under irrigation, and also with certain varieties such as the Chesapeake, Superb, Bubach, and Columbia that do not make many runners. Market gardeners who wish to grow the largest possible quantity of the highest grade of fruit on a small area may also adopt the hill system. Under ordinary conditions, however, matted rows should be used throughout this region, while

in the northern part of the Middle West, where there is danger of winter injury, matted rows should invariably be used.

Whether spacing the plants by hand under the systems, sometimes known as the hedge row or the spaced row will pay can be determined only by trial. Such systems require much hand labor, both in placing the runners that are to form plants and in removing all others that appear. In practice special forms of the matted-row system are used chiefly when varieties of the highest quality are grown by market gardeners or in home gardens.

MARKING ROWS

Except when a machine planter is used, the position of the rows should be indicated by the use of markers, one type of which is shown in figure 6. This will make it possible to set the plants in straight lines. In using a horse cultivator there is less danger of disturbing the plants if they are properly placed, and less hand labor in hoeing will be necessary, since the horse cultivator can be gauged so that it will run close to the plants without disturbing them.

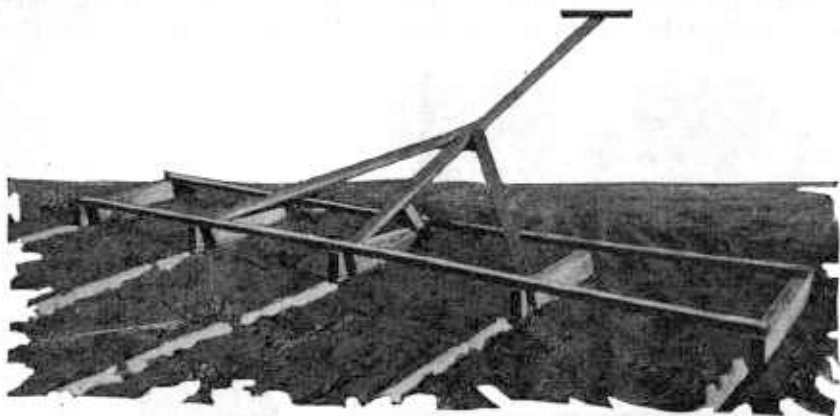


FIGURE 6.—A homemade marker for laying off the rows. By marking across the first rows and setting the plants at the intersections, using a horse cultivator in both directions is made possible.

Fields are easier to cultivate when the plants are set in rows both ways, and if the plants are set $2\frac{1}{2}$ feet or more apart in the rows, as shown in figure 5, *C*, a horse cultivator may be used in both directions until the runners begin to grow freely.

Where it is necessary to get surface drainage by making ridges on which to set the strawberries, the rows are indicated by the ridges; therefore no marking out of rows is necessary.

In marking out a field where the surface is irregular and steep enough to wash badly during heavy rains, the rows should follow the contours of the land as far as possible, and should run the long way of the field for convenience and economy in cultivation (fig. 3).

NUMBER OF PLANTS REQUIRED FOR AN ACRE

The best distance at which to plant differs according to the system, the plant-making habit of the variety, the soil, the slope, the climatic conditions, the danger from white grubs, and the cost of labor.

Table 1 shows the number of plants needed to set an acre of ground when spaced according to the systems commonly used.

Where there is little danger of loss of plants from any cause, only the number specified in table 1 will be needed. If such danger exists, a larger number should be obtained, as caring for a field which has many blank spaces will make the cost entirely out of proportion to the value of the crop obtained.

TABLE 1.—*Number of strawberry plants required to set an acre of ground when spaced at different distances*

Distance	Plants to the acre	Distance	Plants to the acre
2 feet by 1 foot.....	21, 780	2½ feet by 1½ feet.....	11, 616
2 feet by 1½ feet.....	14, 520	3 feet by 2 feet.....	7, 260
3 feet by 1 foot.....	14, 520	3 feet by 3 feet.....	4, 840
3½ feet by 1 foot.....	12, 446	3 feet by 4 feet.....	3, 630

CARE OF PLANTS BEFORE SETTING

When the plants are received from the nursery, the outer and older leaves usually have been removed, and only 1 to 3 young leaves in the

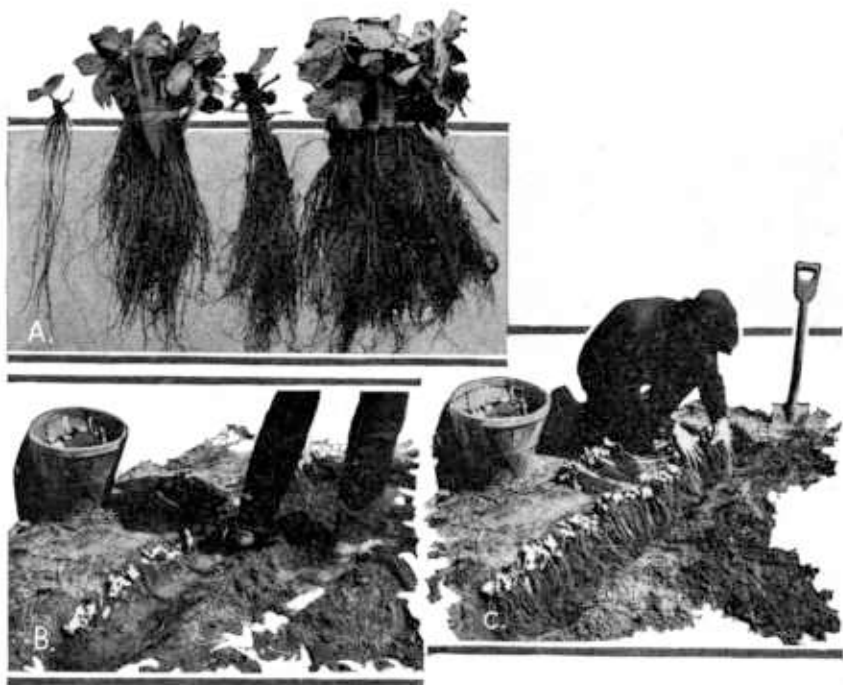


FIGURE 7.—A, Strawberry plants in bundles as received from the nursery: Left, a single plant and a bundle of 27 plants of the Dunlap; right, a single plant and a bundle of 27 plants of the Pearl. All are good plants for setting, though they have very different root systems. Other varieties show even greater differences in the habit and vigor of their root systems. B, C, Caring for strawberry plants received from the nursery. The bundles are opened and each plant placed in a trench separately. They should then be covered with soil to their crowns. (Photographed at Salishury, Md., Mar. 31.)

center left on. Such plants are easier to handle and will grow better than if the older leaves had been allowed to remain. If the plants are

in poor condition, however, all except one small leaf should be removed. The roots should be fresh and bright and usually white or slightly yellowish in color, though if grown on muck soil they will be dark. Old plants can usually be distinguished from young plants because some of their roots are black and dead. Plants in good shape for setting are shown in figure 7, *A*. The roots of these plants have not been pruned, and at present there is no evidence to show that pruning the roots of strawberry plants before setting them is advantageous.

If the plants cannot be set for several days after their arrival, the bundles should be opened and the plants separated and heeled in, as shown in figure 7, *B* and *C*. The crowns should be placed even with the surface of the ground; then the trench filled with soil, which is packed around the roots firmly, so that it is in close contact with all of them.

If the roots are very dry upon arrival, they should be dipped in water and the plants placed in a cool cellar for several hours before being heeled in. When they are heeled in later, the soil which is drawn about the roots of the plants should be moistened thoroughly. If the plants are extremely dry, it may be necessary to allow them to start a new root system while they are heeled in and before they are set in the field.

When being set by hand the plants should be protected from the sun and wind, so that the roots will not dry out. A basket or bucket may be used to hold them as they are being dropped, or they may be put in the bottom of a fertilizer sack which has been cut across one side with a slit across the top to hang the sack about the neck, as shown in figure 8. This protection from the sun and wind is especially important on clear, bright days; on damp, cloudy days less attention is necessary. Not only should the plants be protected while being carried to the field and while in the field, but they should not be dropped much ahead of the setter.

The supply of plants which has come from the nursery should also be protected from sun and wind by covering them with a piece of wet burlap.

SETTING THE PLANTS

Plants may be set with the hand, with a dibble, spade, or punch, or with a machine made for the purpose. Whatever the method used, two things are of special importance in obtaining successful results: Setting the plants at the right depth and making the soil very firm about the roots.



FIGURE 8.—Dropping strawberry plants, showing a good way to protect them from the sun and wind. A fertilizer sack is slit across the front and the plants put in the bottom. Another slit near the top enables the dropper to hang it around his neck. (Photographed at Atmore, Ala., Apr. 8.)

The plants should be set so that the crowns are even with the surface of the ground after the soil has been packed about the roots. The proper depth for planting is shown in figure 9.

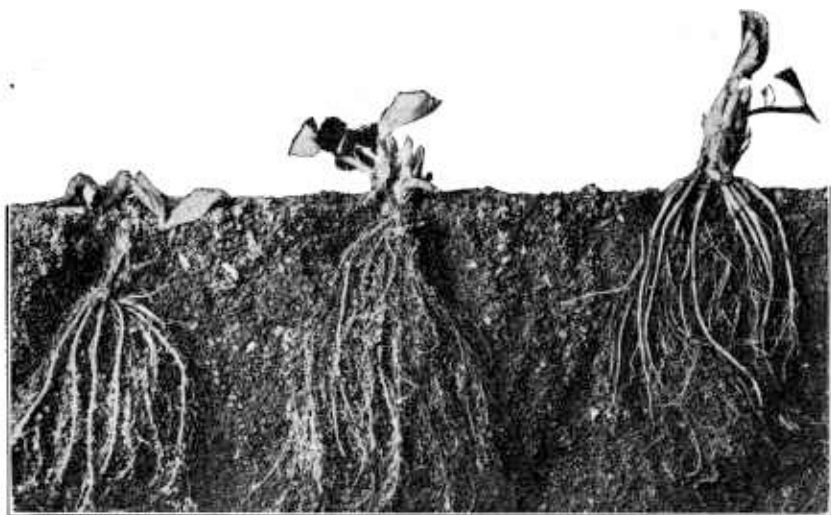


FIGURE 9.—Strawberry plants set at different depths in the soil. At the left is shown a plant set too deep and likely to smother and die; in the center is one set at the proper depth; and at the right is a plant set too shallow, which will dry out.

If the soil is not properly firmed about the roots, air gets to them and they are likely to dry out. Besides, such plants usually will start growth feebly or not at all. If the soil is thoroughly firmed, very little trouble will be experienced in getting plants to live. Some growers step on each plant after it has been set, to firm the soil properly. When this is done the instep should come over the crown of the plant in order to avoid injuring it.

SETTING BY HAND

Setting strawberries by hand is satisfactory only in very loose soils. A wedge-shaped opening about 4 inches deep is made in the soil with one hand and the plant inserted with the other. The earth is then drawn about it and firmed. Plants may be set quite rapidly in this manner, but it is used in only a few localities, as the work is hard and the soil not often sufficiently mellow. It is chiefly used where the plants are set close together and those setting them do not have to move about much.

In most localities an opening is made in the soil with a dibble, trowel, or punch. Dibbles and trowels of different sorts used for this purpose are shown in figure 10. With one of these implements an opening 4 to 6 inches deep is made in the soil, the plant is inserted, and the earth pressed back firmly about the roots.

When a punch, such as is shown in figure 11, *D*, is used, 1 man usually goes ahead making the holes, another follows dropping the plants, and 1 or 2 others place the plants in the holes and draw the earth about them. The punch cannot be used readily in soils which contain straw or stones, but is especially adapted for use in loose

soils. The dibble, however, can be used in any soil that is properly prepared.

A common method of setting the plants is with a spade. Two men form a setting crew. One inserts the spade and by forcing it forward opens a hole. After the roots of the plant have been inserted, he withdraws the spade and with his foot presses the soil firmly about them. The second man carries the plants and inserts them in the holes as they are made by the spade. Plants can be set rapidly in this manner.

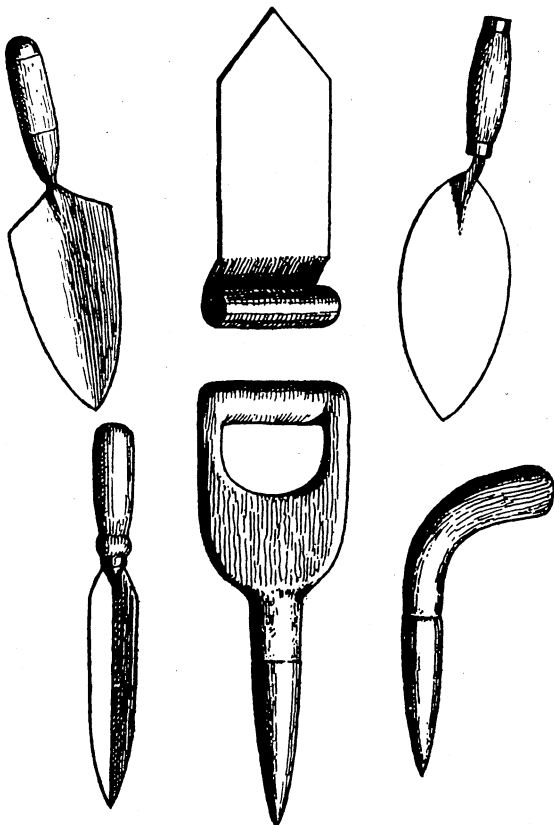


FIGURE 10.—Different types of dibbles and trowels commonly used in transplanting strawberries.

The paddle shown in figure 11, *B*, is another tool often used to set plants. The plants are dropped in the exact place where they are to be set, and a man following presses the roots into the ground with the paddle and thoroughly packs the earth about them with his foot. Plants can be set very rapidly in this way, but the soil must be loose and friable.

A variation of this tool, called a "packer," is shown in figure 11, *A*. The plant is pressed into the ground with the paddle and the earth firmed around it with the packer.

Another device, shown in figure 11, *C*, is a punch and tongs, used more extensively for setting sweetpotatoes than strawberries. A hole is made with the punch, the plant picked up with the tongs and placed in the hole, and the earth firmed with the foot. An experienced worker can set 10,000 plants a day with this instrument, while an



FIGURE 11.—Different methods of setting strawberries. *A*, A "packer." The strawberry plant is forced into the ground with a paddle and the earth firmed around it with the packer, which is fastened to the paddle handle by clips and works up and down on it, as here shown. *B*, Setting a strawberry plant with a paddle. When the soil is very mellow the plants are dropped, the roots forced into the ground with the steel-tipped paddle shown, and the soil firmed with the foot. *C*, A punch and tongs used to set strawberry plants. A hole is made with the punch, the plant is picked up and placed in the hole with the tongs, and the earth firmed about it with the foot. *D*, A crew setting strawberries. The first man levels the top of the ridge or list, the second punches the holes, the third drops the plants, and the fourth and fifth men set them.

expert can set many more. Under favorable soil conditions it is easier to set 10,000 plants a day with this than to set 5,000 with a dibble or trowel.

SETTING BY MACHINE

On level land, planting machines used in trucking sections for transplanting tomatoes, cabbages, sweetpotatoes, and the like are often used to set strawberry plants. The soil should be moist, or water must be applied when the plants are set with this machine. Usually

one man drives the machine and two others feed plants into it. About 30,000 plants, or 3 to 5 acres a day, can be set in this way.

The chief difficulty in the use of a planting machine is that it is hard to get all the plants set at the right depth. After some practice, however, intelligent droppers become so expert that practically all plants are set at the proper depth, with the roots straight down. A roller attached to the planter may be used to firm the soil, or a man may be employed to walk along the rows, firming the plants with his foot. When all conditions are favorable, especially where cool, moist weather may be depended upon for some time after the plants have been set, such a machine may be used very successfully, and the cost of planting will be comparatively low.

CARE DURING THE FIRST SUMMER

REMOVING THE FLOWER STEMS

Flower stems usually appear on strawberry plants soon after they are set in the field. Until the plants become firmly established after transplanting, the production of fruit is a severe drain on their vitality; therefore, if the plants do not start well, or if a drought is occurring, the flower stems should be removed as they appear. Furthermore, if a very large number of plants is needed, or if the variety used does not naturally make many plants, the number of runner plants can be increased very materially by removing the flower stems as soon as they appear. If, however, the plants are thoroughly established in the soil and an especially large number of runner plants is not needed the flower stems need not be cut off.

CUTTING RUNNERS AND THINNING AND SPACING PLANTS

Under the hill system of culture the runners should be cut whenever they appear throughout the summer. A sharp hoe is ordinarily used for this purpose. Occasionally, a circular cutter about 8 or 10 inches in diameter, which cuts runners on all sides of the plants at once, is used. Much labor in cutting runners can be saved if two rolling cutters are attached to the cultivator and set just far enough apart to run between the rows. Most of the runners can then be cut at the time of cultivation. Such a cutter, however, can be used to advantage only where the soil is free from stones and straw.

Under the matted-row system of culture it will usually be necessary to thin the plants in some way during the late summer and autumn. For this purpose rolling cutters may be attached to the cultivator so that all runners extending into the alleys beyond a certain distance will be cut off. Other surplus runners are removed when the field is hoed.

Where the matted row is 2 feet or more in width, growers sometimes use some method to thin the plants in addition to attaching rolling cutters to the cultivator. Some run a bull-tongue plow with a point about 4 or 5 inches wide down the center lengthwise of each row, tearing up the center plants. This leaves the row cut in two parts, or in what might be called a double-matted row. Other growers sometimes run a spike-toothed harrow across the rows in late summer or autumn. The teeth should slant backward, so that only the plants which have not become thoroughly rooted will be torn up. The harrow, however, should be used only after careful trial, as there is some danger that too many plants may be loosened by its use.

Under the more intensive systems of culture, such as may be used in the home garden and in growing fancy berries, the runner plants may be spaced by hand rather than allowed to root at will. When this is to be done, the tips of the runners are covered with earth as soon as they begin to enlarge. The first runner plant should be placed between the mother plants in the rows. The next ones should be placed at the length of one runner out from the original row and on each side of it. There will then be three rows of plants, and all other runners may be removed or additional runners may be rooted until a wide bed has been formed with the plants at least 6 inches apart. Thereafter, all runners should be cut off.

Sometimes it will be found cheaper to allow the runner plants to root at will until the middle of August. All superfluous plants are then dug out and the remainder spaced at equal distances.

TILLAGE

Tillage in newly set strawberry plantations must be very thorough in the early part of the season, in order to conserve moisture so that



FIGURE 12.—A, Field of Aroma strawberries managed by the owner at Bowling Green, Ky. Note the absence of weeds and the presence of a good mulch. B, Field of Aroma strawberries adjoining the field shown above but managed by a tenant. The yield from this field was slightly more than 100 crates of 24 quarts each per acre, while from that shown above nearly 150 crates per acre were harvested.

the plants can become thoroughly established in the soil, and later in the season to conserve moisture so that the plants can develop run-

ners. Weeds and grass should be kept out of the fields, as it is very difficult to eradicate them after they have become established.

Many growers use the cultivator as often as once each week throughout the first season, and during periods of drought even more frequently. Hoeing should be done as often as it is found necessary to clean out all weeds between the plants. Tillage should be shallow near the plants, both because of the danger of loosening them in the soil and because if too deep the roots near the surface will be broken. The teeth on each side of the cultivator should be shortened, so that they will not stir the soil near the rows to a depth of more than about 1 or 2 inches.

Tillage should be kept up until hard frosts occur. Many kinds of weeds continue to grow during the warm periods of late autumn, and start to grow very early in the spring. Therefore, where a mulch is used for a winter covering and to keep the fruit clean in the spring, it is especially important that cultivation be continued as long as there is any chance of weeds growing. The field will then be free from weeds, and in the following year very few will have time to grow before the harvest season.

If weeds are not kept out, they will take the moisture needed by the strawberry plants. Weeds also interfere with the proper pollination of the blossoms by hindering the flight of insects from flower to flower, and many nubbins may result.

In figure 12 two adjoining strawberry fields which have been given different cultivation and mulching are shown. From the field shown in the upper view all weeds were kept out, while in the adjoining field shown below many weeds can be seen. These weeds took the moisture supply and interfered with pollination, and as a result about 1,200 quarts more berries per acre were harvested from the first field than from the other.

COMPANION CROPS

In home gardens and where intensive cultivation is practiced, growers wishing to secure the greatest possible return from their ground often grow vegetables with strawberries as companion crops during the first summer after planting. Nearly all kinds of vegetables may be raised as companion crops, and the thorough cultivation given them will be sufficient for the strawberries.

Such crops as onion sets may be grown in the strawberry rows, as shown in figure 13, *A*, while quick-maturing plants, such as lettuce, radishes, peas, carrots, and beets requiring similar culture, may be grown between the rows, as shown in figure 13, *C*. The berry rows are planted the same distance apart as under ordinary conditions and the vegetables are removed before the strawberry plants begin to spread over the ground to any extent.

When such crops as potatoes, beans, peas, and cabbage are grown with strawberries, other systems are often followed. If cabbage or cauliflower is used, the plants may be set about 6 inches to one side of the rows of berries. The strawberry plants will be shaded to some extent by the leaves of the cabbage and cauliflower, but when these are removed during the summer the strawberries will spread over the ground and occupy the whole space.

When potatoes and beans are used as companion crops, the strawberry rows are usually set somewhat farther apart than in ordinary practice, and the companion crop is planted in the middle of the alleys between the strawberry rows. The berry rows should be at least 4 or 4½ feet apart, and only a narrow mat of plants should be allowed to form. The beans and potatoes are not removed until late in the season in northern districts, and the mat of plants therefore must be narrower than in more southern regions.

STRAWBERRIES AS AN INTERCROP

Strawberries are sometimes planted in apple and other orchards. As a rule this practice is not to be advised, beyond possibly the

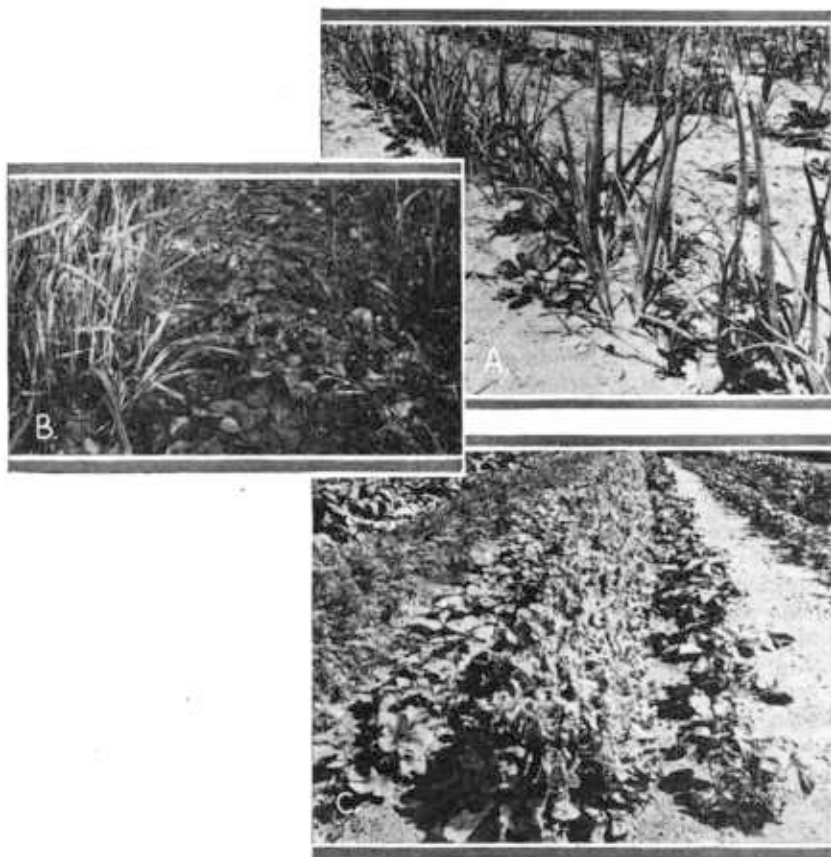


FIGURE 13.—A, Strawberries with onlons as a companion crop. The onlon sets are removed early in the summer and the strawberries can then occupy all the space. (Photographed at Salisbury, Md., June 15.) B, Strawberries growing with an oat mulch. The oats were sown in the alleys in late summer and have made rank growth which, when killed by frost, will fall partly on the plants, protecting them from winter injury and the following year will keep the berries clean. (Photographed at Marlboro, N.Y., Oct. 23.) C, Lettuce, carrots, and beets between rows of strawberry plants. Radishes have already been harvested from the alley at the right. (Photographed at Three Rivers, Mich., July 8.)

planting of a row or two of berries along the center of the space between the rows of trees. This plan leaves free for cultivation a relatively wide strip on both sides of the tree rows. The strawberry plants,

however, even when thus planted, should not be allowed to remain longer than 2 or 3 years.

Strawberries ordinarily are not cultivated in the spring until after the crop is harvested. This covers a period when good tillage is usually very important to the trees. Further, strawberries generally require tillage considerably later in the season than is advisable for fruit trees in the regions to which the directions in this bulletin apply. In other words, the tillage requirements of strawberries and of fruit trees differ so much that they are unsuited for growing together except as above noted.

FERTILIZERS

In general, strawberry growers in the northern United States are using less commercial fertilizer now than formerly. In many cases the additional yield resulting from the application of fertilizers was not sufficient to pay the cost. In other cases growers have found that the crop from fields where fertilizers were applied was actually smaller than that from fields where none were used. Under such conditions most growers have stopped using fertilizer until they could learn the needs of their particular soils.

The use of commercial fertilizers and stable manure in strawberry growing is governed largely by the same principles that apply to other crops. As soils differ greatly in the available plant foods which they contain, the use of fertilizers is largely a local problem, to be determined by each grower for his own conditions. Correct fertilizer practice can be determined by applying the different plant foods, nitrogen, phosphoric acid, and potash to small plots separately, in different combinations, and in varying quantities, and keeping a record of the yields. In like manner different quantities of stable manure should also be applied to small plots, in order to test its value.

A good crop of berries will remove considerable quantities of nitrogen, potash, and phosphoric acid, but most soils are so well supplied with plant foods that strawberries could be grown indefinitely if the physical condition of the soil is good. If, therefore, the soil is kept in a satisfactory condition by the addition of humus and by frequent tillage, and if the moisture supply is ample, many strawberry fields will need no fertilizers or stable manure.

Experiments have shown that in some soils the application of phosphoric acid has greatly increased the yields; in fact, this element of plant food is probably needed more often than any other in the northern part of the United States. Applications ranging from 100 to 700 or 800 pounds per acre should be made in testing the possible value of this element.

Potash has been found beneficial on some soils, but of no value on others. Different quantities, from 50 to 300 pounds per acre, should be used on test plots.

The use of nitrogen has been found profitable in growing certain varieties, especially the Marshall, Glen Mary, Belt (*William Belt*), and Chesapeake. These, as well as some other varieties, seem to need the stimulating effect of this fertilizer in early spring. Some growers use nitrate of soda about a week after the plants have started to grow, applying 50 to 200 pounds per acre. This application is made in the spring of each year following the one in which the strawberries were

set. When nitrogen is applied to plantations of the naturally strong-growing sorts, the foliage may become too rank, the berries may be softer, and the yield less than if no nitrogen were applied. Nitrogen, therefore, should be used heavily only after careful tests have demonstrated its value.

Stable manure is often used in place of nitrate of soda or in addition to it. When needed it should be applied in the autumn in the form of a mulch and will help to protect the plants from heaving and from severe winter weather. The nitrogen in the stable manure helps to stimulate a heavy leaf growth. In addition, stable manure contains the other elements of plant food, as well as large quantities of humus. Amounts ranging from 8 to 50 tons to the acre are used by commercial growers, although applications of 15 to 20 tons are most common. However, tests should be made by each grower to determine the best quantities for his conditions.

WHEN TO APPLY FERTILIZERS

The time of applying fertilizers varies greatly. Some growers apply potash and phosphoric acid before or at the time of setting the plants; others make a portion of the application then and the rest during early summer. Conditions vary so greatly that no rule can be given, and each grower must determine for himself when to apply these elements.

When potash and phosphoric acid are used before the plants are set, they may be broadcast or drilled in where the plant rows are to be. Later applications may be drilled in along the rows or scattered on top of the plants. In the latter case, a brush should be dragged over the rows to remove the fertilizer from the leaves in order to prevent burning the foliage. When a plantation is to be renewed, the potash and phosphoric acid should be applied at the time of renewal.

USE OF LIME

Experiments have shown that lime has a harmful effect on the roots of strawberries. Sometimes, however, where the soil is in poor physical condition, it may pay to use small quantities of lime to improve soil conditions. However, it should be applied broadcast considerably in advance of setting the plants. If legumes are used in a rotation, and lime is needed, it will be best to apply it before the green-manure crop is grown.

IRRIGATION

In many sections of the northern United States severe droughts cause considerable loss to strawberry growers. If droughts of greater or less severity come during the fruiting season, the berries do not reach full size, and much of the crop may be too small to market. Where such droughts frequently occur during the period when the fruit is developing, irrigation may be desirable. Where it is practicable to install an irrigation system the water needed for the establishment and proper growth of the young plants and for the development of the runners is very largely under the control of the grower. Furthermore, if a drought occurs early in the growing season, the field may be irrigated regularly and a full crop secured.

To make irrigation practicable, there should be an abundant supply of water near the field to be irrigated. The crop must be grown under an intensive system of culture, as the cost of installing an irrigation system is considerable, and materially increases the investment on which the grower must make adequate returns if his strawberry enterprise is to be financially successful.

The installation of an irrigation system is a permanent improvement on the farm, but it should not be made until the possibility of securing the labor necessary to grow intensive crops is fully assured.

OVERHEAD IRRIGATION

An overhead sprinkling or spray system of irrigation is used quite extensively in southern New Jersey, while smaller area irrigating in this way has been found profitable in nearly all of the Northern States. Surface irrigation has been used very little in these States; it can be employed only on fields which have gentle, uniform slopes and either a rather heavy surface soil or a heavy subsoil at a slight depth below the surface of the ground. The spray system, however, has no such restrictions.

In figure 4, *A* and *B*, are shown overhead spray irrigation systems in New Jersey, and *C* illustrates this system as used in Michigan. In the New Jersey fields shown the Chesapeake strawberry is grown. Crops of 8,000 quarts per acre and more of this variety have been obtained under irrigation when not more than 3,000 quarts were secured on similar soil in an adjoining field not irrigated. The Chesapeake has been found to respond especially well to irrigation.

As the cost of a system of overhead spray irrigation will range from \$80 to \$250 or more per acre, growers should, whenever possible, obtain information on the experience of others in the use of irrigation before investing heavily.²

SURFACE IRRIGATION

For many home gardens, as well as in commercial plantations, surface irrigation will be found satisfactory. The rows should not be more than 200 to 250 feet long, and furrows should be made in the alleys to direct the flow of the water. Surface irrigation is better adapted to silt and clay than to sandy soils.

MULCHING

In the northern part of the Middle West all varieties of strawberries must be protected in the winter against the severe drying winds which occur in those regions. Where the ground has a covering of several inches of snow throughout the winter, a mulch is not ordinarily needed for protection against the cold. In regions of heavy snowfall, however, the plantation often needs a mulch to keep the ground from freezing and thawing in early winter and in the spring. Clay soils heave when they freeze and thaw, and the plants may be thrown entirely out of the ground, or their roots may be broken so that they will dry out and die. A mulch also conserves moisture in the spring, and in certain localities and under some conditions the crop may be

² U.S. Department of Agriculture Farmers' Bulletin 1529, entitled "Spray Irrigation in the Eastern States," gives detailed information on the installation of spray-irrigation equipment.

increased from one third to one half by its use. The mulch also helps to keep down weeds, which interfere greatly with the pollination of the flowers and with picking. During the harvesting season, a mulch keeps the berries clean and protects them from the soil when rains occur. A heavy mulch may delay the ripening season for several days.

The disadvantages of mulching are that when unseasonable frosts occur in the spring the blossoms may be more severely injured where a mulch is used than where it is not. It is often several degrees cooler at the surface of the ground where there is a mulch than where there is none. Another possible disadvantage is that the mulch sometimes contains weed seeds, which germinate and so add to the expense of caring for the plantation. Where suitable material is difficult to secure, the application of a mulch may be very costly.

Among the materials used for mulching are stable manure, straw, pine needles, ferns, wild hay, and crops grown for this special purpose. With such varieties as the Marshall, Glen Mary, and Belt (*William Belt*), which need stable manure to force them into rapid growth in the early spring, strawy stable manure is considered most desirable. This should be applied late in the autumn after the ground has begun to freeze but before it has frozen more than 1 to 2 inches deep; 10 to 20 tons per acre may be used. Stable manure is also used to mulch the Progressive and the Chesapeake, and even larger quantities may be used profitably with these sorts. In parts of New Jersey where the Chesapeake is grown under irrigation, many use 20 to 30 and even 40 tons of stable manure to the acre. Some kind of straw is perhaps more commonly used than any other mulching material, and wheat, rye, oat, and buckwheat straw mulches have been found satisfactory. Such material, however, should be as free as possible from grain and weed seeds, as these sometimes start to grow in the spring and become troublesome. From 2½ to 5 or 6 tons of straw or 1 to 3 tons of marsh hay per acre are often used. Figures 4 (*A* and *B*) and 5 (*B*) show fields mulched with stable manure and straw.

Wild hay, ferns, and pine needles are very satisfactory if they can be secured at small cost.

The mulch may be grown in the strawberry field if it cannot be obtained readily and cheaply elsewhere. Oats are most commonly used for this purpose and should be sown in the alleys between the strawberry rows in August or September (about 50 days before a killing frost is expected) at the rate of 1 to 2 bushels per acre. They should not be sown too thickly or too close to the strawberry plants, as there is danger of smothering them. The oats, which should have reached a height of 1 to 2 feet if they have 50 days of growth, are killed by the first hard frost and form a good mulch between the rows and over the plants. Weeds are crowded out by the oats, so that less cultivation in the autumn is needed. Figure 13, *B*, shows strawberries with oats grown as a mulch. A mixture of kafir and sorghum or of oats and sorghum may be used instead of oats and is preferred by some.

In the North Central States, where the soil is likely to freeze and thaw several times during the winter or where cold drying winds occur, the mulch should be applied as soon as the ground is frozen enough to allow driving over the field. In some localities growers have found it unsafe to await freezing weather, because of the danger

of severe storms or heavy falls of snow which remain throughout the winter, and they put the mulch on as soon as active growth has ceased. Where it is desirable to delay the ripening season, the mulch may be applied in early spring before the snow has melted. The mulch will delay the melting of the snow and retard the growth of the plants and the ripening season for several days.

In the more southern areas, such as Delaware, Maryland, Kentucky, southern Illinois, Missouri, and southward, where the ground freezes late in the autumn, mulching may be delayed as late as December.

The mulch should be scattered over the fields so that some will fall on the plants, but more of it between the rows. Figure 14 shows how it is applied. In the spring the plants will grow up through the straw, and the berries will thus be kept clean. If the mulch is very heavy, it may be necessary to go over the fields when growth starts and rake some of it into the alleys between the rows.

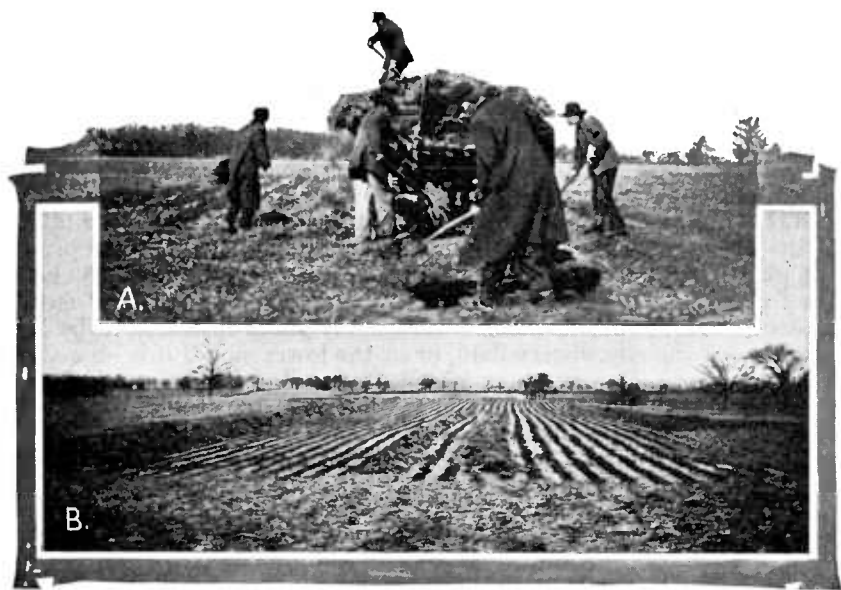


FIGURE 14.—Mulching a strawberry field (A) at Bowling Green, Ky., with wheat straw, and (B) a field shown when partly mulched. The straw was thrown off the wagon in windrows, as shown, and spread by hand over the rows of plants. The straw is usually drawn on after the ground is frozen.

In most localities where the land is fairly free from weeds or where the kinds of weeds that occur do not start growth early in the spring, the mulch may be left on the plantation until after the harvesting season. Where there are weeds which grow rapidly in early spring, either the mulch should be removed from the alleys to the tops of the rows and the cultivator run through the alleys once or twice and then the mulch returned to the alleys, or the mulch should be left in place and the weeds pulled by hand. Where the weeds are not too abundant the latter method may be more satisfactory. Although cultivation or the pulling of weeds may disturb the roots of the strawberry plants to some extent they will suffer less than if compelled to compete with the weeds for moisture, and it is much better to cultivate, hoe,

or pull the weeds than to leave them to grow in the fields. In all cases, therefore, the weeds should be removed, even up to the time when picking commences. If the weeds are pulled when small the roots of the strawberry plants will be disturbed less than if the weeds are neglected until they become large.

FROST PROTECTION

Where the strawberry is frequently injured by unseasonable frosts in the spring, various methods of protecting the flowers may be used.

Where material for mulching is fairly cheap it may be raked from the alleys to the top of the rows the day before a freeze is expected. This involves considerable hand labor and is costly, but will sometimes prove profitable. It is possible to delay the blossoming period a few days by covering plants with a heavy mulch in the autumn and leaving it on as late as possible. When the weather becomes warm and growth has begun, part of the mulch should be placed in the alleys and the remainder left over the plants.

Where overhead spray irrigation is practiced it is possible to start sprinkling late in the evening and continue until after danger from frost is over the next morning. This will protect the plants very largely from frost injury.

Smudging and heating are occasionally practiced. The strawberry plant, however, is close to the ground, where the temperature is lowest, and it is difficult to raise the temperature of the air next to the plants. If the heaters are used, 125 to 150 per acre will be needed to protect the plants from a frost when the temperature drops to 6° or 8° below the freezing point at the surface of the ground. If fires are used to protect the strawberries from frosts, many small fires should be built throughout the strawberry field, or at the lower side if it is on a slope.

Late-blossoming sorts may be selected in some cases or, if frost is expected very late in the spring, the everbearing varieties should be grown.³ If the first blossoms of these are killed they will send out a new set of flower buds and produce a crop of fruit in due course provided other conditions are favorable.

PICKING

The different varieties of strawberries differ somewhat in the degree of maturity at which they should be picked. Varieties with soft flesh must be picked before they are very ripe, in order to get them to market in good condition. Firm varieties, however, may be left on the plants until thoroughly ripe, and will have a better appearance on the market than those picked when not fully ripe.

Varieties also differ greatly in the length of the picking season. Many, like the Gandy, have a very short season of 10 days or 2 weeks, while others, like the Campbell, have a relatively long picking season, which may last 4 weeks or even longer. The grower must plan his work according to the habit of the variety.

Varieties differ also in the frequency with which they need to be picked. Usually the berries should be picked every other day, but certain varieties may be left 3 days between pickings, while still others should be picked daily.

³ See Farmers' Bulletin 901, entitled "Everbearing Strawberries."

The length of time that the fruit will stand up after it has been picked depends upon the variety, the degree of ripeness, the care with which it is handled, and the temperature of the berries at the time they are picked and at which they are held after picking. Experiments have shown that for each rise in temperature of about 15° F., the life of the berry, other things being equal, is decreased one half—that is, if the strawberry will keep for 8 days in good condition at a temperature of 40° , it will keep for only 4 days at a temperature of 55° , only 2 days at a temperature of 70° , and only 1 day at a temperature of 85° . If the berries are picked in the early morning when they

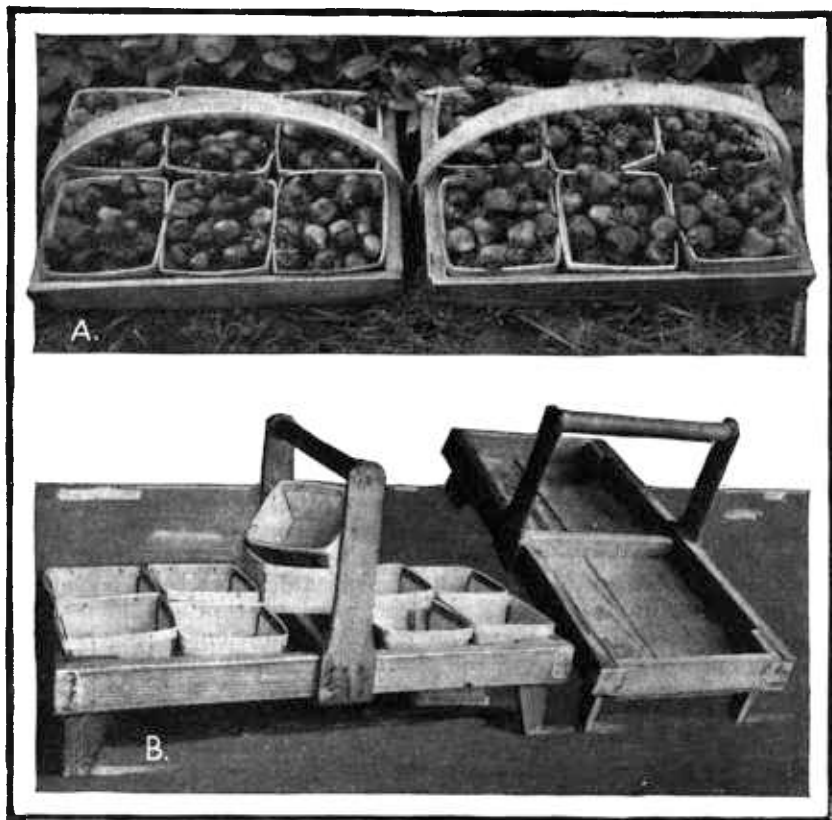


FIGURE 15.—*A*, Two 6-quart carriers filled with Chesapeake strawberries. These carriers are commonly used in picking berries. *B*, Carriers holding 1-quart baskets used to carry strawberries from the field to the packing house.

are relatively cool, and put at once in the shade, they will keep much better and have a much better appearance on the market than if picked at midday when they are warmer, or if left in the sun after picking.

Carriers used in picking berries are shown in figure 15. The 6-quart carrier illustrated (*A*) is commonly used for picking, and the 10- or 12-quart carriers (*B*) are used to carry the berries to the packing house. Such carriers are used only when the packing is done at some little distance from the place where the berries are being picked. In

smaller fields, where the packing house is located within a short distance of the pickers, each picker usually carries his berries to it, and the larger carriers are unnecessary.

RENEWING THE PLANTATION

The number of crops harvested from a plantation varies greatly in different parts of the country. In some localities, 1 crop only is harvested, and then the field is plowed up; in others, 2, 3, or even more crops are secured. The length of time the plantation should be kept depends upon the variety, the number of weeds in the field, the character of the soil, and the comparative cost of renewing an old plantation and setting a new one.

Certain varieties of strawberries produce their largest crop the first year after setting, while others yield a larger crop the second and third years. Plantings of varieties that often bear a larger crop the second season than the first, such as the Klondike in Delaware and the Gandy in New Jersey, should be continued for at least 2 years. From plantations of some varieties, such as the Aroma, for example, very large crops will be secured for a number of years, and if possible, fields of such varieties should be kept for several seasons.

Where certain kinds of weeds, such as white clover, purslane, chickweed, and crabgrass, are prevalent, it may be necessary to plow up the plantation after only one crop has been obtained. When white clover starts in a plantation, it is almost impossible to eradicate it, and the cost of eradication is usually much greater than that of setting out and growing a new plantation. The same is often true when some other weeds become established in the strawberry field.

In many localities where the soil is not well supplied with humus, one crop only should be harvested before the plantation is renewed. The yields after the first year are too small to be profitable. Ordinarily, in such sections, it will pay to turn under green-manure crops or apply stable manure before the strawberries are set, in order that the plantation may be kept profitable more than 1 year.

The length of time that a strawberry plantation should be maintained depends, therefore, upon several conditions. Wherever intensive culture is practiced, the plantation usually should be kept for at least 3 crops, and sometimes for 5 or 6 crops or as long as it gives paying returns. The cost of renewing a plantation under ordinary conditions is less than the cost of setting out the plants on a new field and taking care of such a plantation until midsummer, the time when an old plantation is renewed.

MOWING THE FIELD

In renewing a plantation, the field should first be mowed over. Fields of plants trained to the matted-row system are usually mowed by machine, while the foliage of plants under the hill system may be cut off with a scythe, sickle, or sharp hoe, as shown in figure 16. In the extreme North, where the growing season is short, the foliage should be mowed as soon as the crop has been picked. Where the growing season is longer, the mowing may be delayed for several weeks. Thus, in a region like Delaware, where there is a comparatively long growing season, the foliage need not be cut until some time in August.

If injury from insects and diseases is not serious, the mulch and leaves should, if possible, be turned under when the plowing to thin the plants is done. This will increase the humus content of the soil and put it in better condition than if foliage and mulch are burned. When the mulch is very heavy, however, it may be necessary to remove a part of it before plowing. The mulch may be raked up and stacked for use the following year if it is not too much decayed. In that case only the strawberry foliage that has been cut off is plowed under.



FIGURE 16.—Strawberry plants (at right) which have just had their tops cut off. This should be done with a hoe or a mowing machine immediately after the crop has been harvested. (Photographed at Vashon, Wash., Aug. 7.)

BURNING LEAVES AND MULCH

Where insects and leaf-spot diseases are prevalent, growers prefer to burn the foliage and the mulch without removing them from the field. It is then easier to thin the plants and narrow the rows than if the mulch and leaves are left on the ground. In some localities and with certain varieties, as soon as the foliage has dried, the mulch should be raked on top of the rows, and when a good breeze is blowing in the direction in which the rows run, the fire should be started on the windward side. When handled in this way, the fire will pass quickly. If the ground is very dry or if the mulch and leaves are damp, the roots and crowns of the plants are likely to be injured. As the crowns of some varieties are more tender than those of others, a test should be made before burning over a field of a variety not previously subjected to such treatment. In some localities the Dunlap and other varieties are severely injured if the mulch is over the plants when burned. Where such sorts are grown, the leaves and mulch should be raked into the alleys between the rows before burning.

A few growers practice burning over their fields in early spring before growth starts, and in this way they remove diseased foliage and insect eggs. If the leaves are not dry enough to burn quickly, coal oil may be sprayed on the plants to hasten the burning. The mulch, of course, should be removed before the field is burned over, and should be replaced afterward.

THINNING THE PLANTS

When renewing a plantation, it is desirable to reduce the number of plants in the matted row after the crop is harvested, so that new runner plants may develop. The amount of thinning necessary will depend upon the variety, and to some extent upon the season and the soil. If the variety raised is one that will make a large number of runner plants later in the year, the row should be reduced to 6 or 8 inches in width, and the plants in this row thinned so that they are at least 10 inches apart. If the variety does not make many runner plants in late summer and autumn, the row should be left 12 or 15 inches wide and the plants about 10 inches apart.

To reduce the width of the row either one side or a part of both sides should be plowed up. Usually it is best to plow up one entire side of the row, and also the old plants in the middle. This will leave only the young plants on one side. These remaining plants are then thinned by running a spike-tooth harrow or a cultivator across the rows once or twice and then once down the row. The weaker plants are torn up and the ridges made by plowing up one side of the row are leveled. Hoes may then be used to thin out the remaining plants, if they are still too thick. The crowns of the plants that are left are usually covered with an inch or two of soil. Within 2 or 3 weeks the plants will have sent out new foliage, and the field will have the appearance of a young plantation.

In many cases the location of the rows is changed by plowing up one side of each one year and having the remaining plants set runners in the alleys. The second half of the old row of plants is plowed up the following year, so that by the third year the rows run where the alleys were the first year.

If the narrow matted-row system is used it may be necessary to reduce the width of the rows very little, if at all. A shovel cultivator may then be used to plow across the rows, leaving the plants in small clumps about 24 inches apart. Later in the summer the runners will fill the spaces thus plowed up and make continuous matted rows by winter.

PROPAGATION

Strawberries are propagated commercially by the use of runner plants only, but they can be propagated from seed and by dividing the crowns. Most plants raised from seed will bear fruit inferior to that borne by the parent plants, and none of the seedlings may resemble the parents closely. Dividing the crowns of strawberry plants to make new plants is too slow and expensive for ordinary use. Propagation by runner plants offers, therefore, the only practicable method of securing large numbers of plants of a desirable variety.

PLANTS FOR SPRING SETTING

After a grower has once established a strawberry field, he usually can procure plants for setting from his bearing plantation. For spring planting, the best practice is to use the younger plants along the sides of the alleys in the matted rows. This will secure plants which rooted late the previous autumn, and which will be more likely to start a vigorous growth on transplanting than the older plants which are ready to start fruit bearing. In digging plants, the roots of those which are to remain should be disturbed as little as possible.

PLANTS FOR FALL SETTING

For August and September planting, growers should select plants having the best root systems and the largest crowns obtainable. Such plants will produce larger crops the following year than weaker plants.

Both pot-grown and field-grown plants are used for late summer planting. To raise pot-grown plants, small pots filled with rich earth are plunged into the ground near the parent plants, and the first runners to appear are made to root in them. These potted plants can be transplanted with the least injury to the root systems and with a likelihood of best results the following year (fig. 17).



FIGURE 17.—A Marshall strawberry plant grown from a runner in a "plunged" pot. This plant is larger than the average of those produced in August or September. It may be planted with little or no disturbance of the roots and will bear fruit the next season.

If the plants are to be dug in the field where the runners have rooted in the ground, those with the thickest crown and best root systems should be selected, and the greatest care must be used to protect their roots from injury by the sun or drying winds.

Strawberries raised on clay soil are difficult to transplant. Growers who have no other soil often prefer to procure plants from other localities rather than attempt to use their own stock. Sandy soil should always be chosen for a strawberry-plant nursery.

PLANTS WITH PERFECT AND WITH IMPERFECT FLOWERS

Strawberry varieties in cultivation have two types of flowers, perfect and imperfect. Figure 18 shows the difference between these two flowers. It will be noticed that the perfect flower has both pistils and stamens, while the imperfect one has only pistils. To produce berries, pollen from the stamens must be carried by wind or insects to the pistils. Therefore, varieties having perfect flowers will produce a crop of fruit when set by themselves, while those having imperfect flowers will not bear fruit unless planted near perfect sorts.

Most of the varieties cultivated extensively at the present time are the perfect sorts. A few very productive sorts have imperfect flowers, but they are not more productive than many perfect sorts. Imperfect sorts are widely grown in certain localities where the weevil is very destructive, because that insect feeds on the immature pollen found in the buds of perfect-flowered sorts, but leaves varieties having imperfect flowers almost untouched.

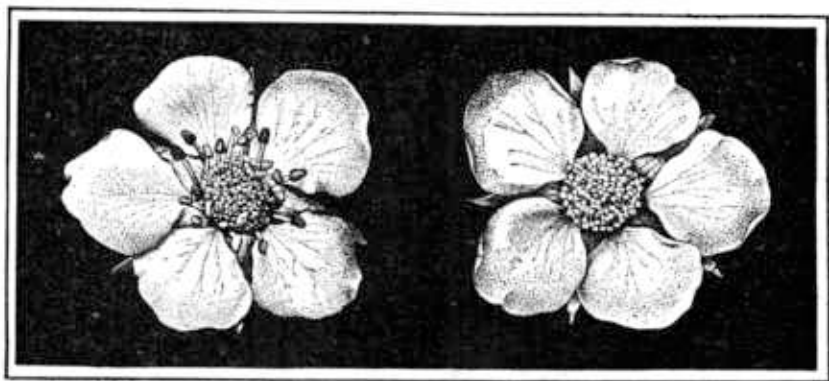


FIGURE 18.—A perfect or staminate strawberry blossom (at the left), having both pistils and stamens, and an imperfect or pistillate blossom (at the right), having pistils but no stamens. Imperfect varieties will not produce fruit unless grown near plants having perfect or pollen-producing blossoms.

Whenever imperfect varieties are planted, there should be at least 1 row of a perfect variety to every 3 rows of the imperfect one, and it is usually better to plant 1 row of the former to every 2 of the latter. A few growers prefer to mix the plants of both sorts in the same row, but as varieties differ in their shipping quality and in their shape, size, and color, and as the markets prefer to have each variety in a basket by itself, this practice should be discouraged.

Pollination is influenced not only by the variety, but by the weather conditions, by the amount of moisture in the soil, and by weeds. When rainy weather occurs at blossoming time, some varieties, such as the Glen Mary, which are not strongly staminate, do not develop sufficient pollen to make them fully self-fertile. These sorts should be interplanted with some strong pollen-producing variety. In seasons of extended drought the plants may not be able to get sufficient moisture to develop the flowers properly, and small berries, frequently poorly pollinated, result.

USES OF THE STRAWBERRY

Many million dollars' worth of strawberry products are manufactured each year. Among the more important of these are preserves, jams, essences for flavoring candies and for use as flavoring extracts, sirup for soda fountains, and crushed fruit for flavoring ice cream and sauces. Large quantities of strawberries are also canned. The varieties commonly used for these purposes are deep red to the center, acid (with a strong strawberry flavor), and so firm fleshed that they will not break to pieces in cooking. Among the best for such purposes are the Klondike, Wilson, and Clark. In localities to which these sorts are not well adapted, the Parsons, Superior, Marshall, Warfield, Dunlap, Gandy, Joe, Missionary, and others are grown.

Many factories for utilizing the strawberry have been erected in the large producing areas. Other factories, to which the fruit is shipped, are located in the cities. The managers of these factories have found that the strawberry is in the best condition for use if picked while very firm, even before it is fully ripe, and made up the same day. The factories located in the producing areas, therefore, can make the finest product. In utilizing strawberries in the home or for the market, the experience of those concerns in selecting certain varieties and in using firm berries the same day they are picked should be followed.

COLD STORAGE ⁴

Fresh strawberries can be stored commercially only for very short periods. Ten days is the usual maximum storage period even when the berries are held at a temperature of 32° F. After about 10 days, sometimes sooner, the fruit loses its fresh bright color, tends to shrivel, and deteriorates in flavor. At temperatures of 40°, or above, loss from decay caused by fungi may become serious. Gray mold rot, Rhizopus rot, and leather rot are the most common storage diseases of strawberries.

FROZEN PACK

The frozen-pack method is used to preserve large quantities of strawberries each year.⁵ Frozen-pack berries are largely used for fruit sirups and crushed fruit required by the soda fountain, ice cream, baking, and confectionery trades, and for making jams, preserves, and jellies. An increasing retail trade in frozen berries for dessert purposes is also developing. At the present time about 90 percent of the frozen berries are packed in barrels, kegs, or 30-pound cans for the larger users. One-pound paraffined paper cups are generally used for the retail trade.

Most of the barrels or kegs used are coated with paraffin on the inside to prevent the berries from absorbing a woody taste. Some of them, however, are made of certain woods that require further treatment to prevent the berries from absorbing the taste of the wood. Enameled cans are used to avoid corrosion. All containers must be made as nearly airtight as possible to preserve the color and flavor of the fruit. The barrels will hold 450 pounds of berries and sugar when 2 parts of berries to 1 part of sugar are used.

⁴ Prepared by D. F. Fisher, principal horticulturist, Bureau of Plant Industry.

⁵ See U.S. Department of Agriculture Technical Bulletin 148, entitled "The Frozen-Pack Method of Preserving Berries in the Pacific Northwest."

In preparing the fruit for freezing the berries are hulled, sorted, and washed, various types of washing machines being employed. Usually there is a water tank into which the berries are dumped for a brief period to loosen the dirt. They are removed from this tank by an endless conveyor belt which carries them under sprays of fresh water, and are then delivered to inspection belts where they are allowed to drain and the final sorting and grading is done. The berries are then run into barrels or other packages, together with the desired quantity of sugar.

While it may be desirable to vary the proportion of fruit to sugar with different varieties of berries, depending on the particular use to be made of the fruit, the usual commercial proportion is either 2 or 3 pounds of berries to 1 pound of sugar. In packing the larger containers the berries and sugar are added in alternate layers to insure more thorough mixing. While it is being filled the container is usually jolted, either mechanically or by hand, to insure each berry being coated with sugar. After being filled, the barrels are headed and the smaller containers are tightly lidded. They are then transferred to a freezing room as soon as possible. A temperature of 0° F., or below, in the freezing room is desirable for barrels and large containers, in order to quickly reduce the temperature of the large mass of warm fruit and thus prevent fermentation and spoilage, and to freeze the fruit in the center of the barrel as quickly as possible. In the small-size containers, especially the 1-pound "consumer packages," satisfactory frozen products can be obtained by using a temperature of 15° for both freezing and storage. After the barreled fruit is frozen, a storage temperature of 15° is satisfactory. While it has been generally believed that very rapid freezing with special equipment was necessary, investigations by the Department of Agriculture have proved that it is not required, and that for some fruits it may be less desirable than a more moderate rate of freezing such as may be obtained in most cold-storage plants.

From 40,000 to 74,000 barrels, each holding 450 pounds of strawberries and sugar, were preserved by the frozen-pack method in the Pacific Northwest during the years from 1927 to 1931. In comparison, the pack in small-size consumer packages was very small, only about 112,000 of these containers being packed in 1931.

The frozen-pack method is highly specialized and its problems are being intensively investigated by the Department of Agriculture. It is recommended, therefore, that the latest information be obtained from the Department before large investments in the business are made.

**ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE
WHEN THIS PUBLICATION WAS LAST PRINTED**

<i>Secretary of Agriculture</i>	HENRY A. WALLACE.
<i>Assistant Secretary</i>	REXFORD G. TUGWELL.
<i>Director of Scientific Work</i>	A. F. WOODS.
<i>Director of Extension Work</i>	C. W. WARBURTON.
<i>Director of Personnel and Business Administration.</i>	W. W. STOCKBERGER.
<i>Director of Information</i>	M. S. EISENHOWER.
<i>Solicitor</i>	SETH THOMAS.
<i>Bureau of Agricultural Economics</i>	NILS A. OLSEN, <i>Chief.</i>
<i>Bureau of Agricultural Engineering</i>	S. H. MCCROBY, <i>Chief.</i>
<i>Bureau of Animal Industry</i>	JOHN R. MOHLER, <i>Chief.</i>
<i>Bureau of Biological Survey</i>	PAUL G. REDINGTON, <i>Chief.</i>
<i>Bureau of Chemistry and Soils</i>	H. G. KNIGHT, <i>Chief.</i>
<i>Office of Cooperative Extension Work</i>	C. B. SMITH, <i>Chief.</i>
<i>Bureau of Dairy Industry</i>	O. E. REED, <i>Chief.</i>
<i>Bureau of Entomology</i>	C. L. MARLATT, <i>Chief.</i>
<i>Office of Experiment Stations</i>	JAMES T. JARDINE, <i>Chief.</i>
<i>Food and Drug Administration</i>	WALTER G. CAMPBELL, <i>Chief.</i>
<i>Forest Service</i>	R. Y. STUART, <i>Chief.</i>
<i>Grain Futures Administration</i>	J. W. T. DUVEL, <i>Chief.</i>
<i>Bureau of Home Economics</i>	LOUISE STANLEY, <i>Chief.</i>
<i>Library</i>	CLARIBEL R. BARNETT, <i>Librarian.</i>
<i>Bureau of Plant Industry</i>	WILLIAM A. TAYLOR, <i>Chief.</i>
<i>Bureau of Plant Quarantine</i>	LEE A. STRONG, <i>Chief.</i>
<i>Bureau of Public Roads</i>	THOMAS H. MACDONALD, <i>Chief.</i>
<i>Weather Bureau</i>	CHARLES F. MARVIN, <i>Chief.</i>

<i>Agricultural Adjustment Administration</i> ----	GEORGE N. PEEK, <i>Administrator.</i>
	CHAS. J. BRAND, <i>Coadministrator.</i>